The Spillover Effects of Real Estate*

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Abstract

We examine the spillover effects of the "Three-Red Lines" policy, a Chinese regulatory measure in 2020 that imposed leverage reduction requirements on the real estate sector. Using a firm-level exposure measure, we find that higher exposure to the real estate sector leads to more pronounced adverse impacts on firms' financing costs and real economic activities. Moreover, these spillover effects transmit through the production network, affecting both upstream and downstream sectors closely connected to real estate. Notably, trade credit plays a significant role in explaining these observed spillover effects.

Keywords: Spillover, Real Estate, Production Network, Trade Credit

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1 Introduction

The real estate sector's extensive industry and financial linkage makes it lie at the heart of a country's macroeconomy. For example, a large collapse in real estate prices can affect both the corporate and household sectors through a collateral or wealth channel (e.g., Gan 2007, Iacoviello and Neri 2010, Mian, Rao, and Sufi 2013). More recently, a few Chinese real estate developers, such as Evergrande and Country Garden, have continuously failed in their debt obligations to international investors, which has generated concerns about the impacts of a burst of China's real estate bubbles on both the domestic and global economies.

How large is the spillover effect of the real estate to other sectors of the economy and through what mechanism? This question is important as downturns in real estate typically end up with crises and recessions. Famous examples include the Japanese real estate burst and the U.S. subprime crises. Empirically, however, the spillover effect is hard to estimate and subject to endogeneity concerns including reverse causality from other industries to real estate demand and numerous confounding factors (e.g. monetary policy changes and COVID lockdowns).

In this paper, we use a unique Chinese policy announcement of the three-red-line policy to address the above question. China's recent regulation on real estate sector provides an ideal quasi-experiment for the following two reasons. First, the real estate sector is an important part of the Chinese economy. As of 2022, for example, real estate industry accounts for 26% of GDP in China (Rogoff and Yang 2022). Moreover, land sales income is 6.7 trillion RMB, 61% total revenues for local governments.

Second, the three-red-line policy was unexpected and unprecedented. It was announced on August 20, 2020, by the Ministry of Housing and Urban-Rural Development and the People's Bank of China (PBOC). Based on the liability structure of the real estate firms, the policy puts restrictions on three accounting variables. Violating each of them is termed as crossing a red line. Depending on the number of lines violated, the policy grouped firms into four categories, red (three lines violated), orange (two lines violated), yellow (one line violated), and green (no line violated). Real estate firms are not allowed to take more leverage depending on their categories, with the cap on the annual growth rate of the liabilities with interest at 0%, 5%, 10%, and 15% respectively. While many housing regulatory policies, such as housing purchase restrictions, a raise of minimum down payment ratio, or a restriction of bank lending to real estate sector, have been imposed on the household and banking sectors, the three red-line policy is the first regulatory policy to constrain the liability of real estate developers to contain housing speculation.

To identify the causal effects of the three-red-line policy, we construct a firm-level exposure to this policy for non-real estate listed firms in China. Our exposure measure utilizes information on the cross-sectional impact of the policy on the real estate firms and the pre-shock stock return correlation with the real estate sector. We then estimate the real spillover effects on non-real estate firms.

The main identification challenge is to isolate changes in non-real-estate firms' performances that are driven solely by the impacts of three red-line policy to the real estate from unobserved factors that influences both non-real-estate sectors and real estate sectors. To this end, we use individual firms' stock returns data to construct a measure of firm-level exposure to the three red-line policy. Our methodology exploits two sources of variations: first, the degrees of violation of three red-line policies are heterogeneous across Chinese real estate developers when the policy was announced; second, individual non-real-estate firms have different pre-existing exposures to troubled real estate developers, as captured by the correlation of their stock returns with the stock returns of individual real estate developers. Similar to the methodology used by Chodorow-Reich (2014), we construct our firm-level measure of exposure for non-real estate firms to three red-line policy using the number of lines violated by real estate firms and individual firms' pre-policy stock return correlation with the non-real firms as weights. We then estimate the spillover effects of the "three red-line regulations" on firms in other sectors of the economy using a difference-in-difference method. We carefully control for the effects of potential confounders such as COVID lockdown and firm-level correlates to our exposure measure.

Our first result is about the financial impact. We find that during the policy period, both stock return and bond spread respond more for firms with a higher exposure measure. Economically, a one-standard-deviation increase in the ex-ante exposure to the policy reduces the 10-day cumulative abnormal stock returns by 0.18% and increases bond spread by 33 bps on a daily frequency.

We also explore the real effect considering that the policy might have a persistent impact on the real economy. We find that firms with more exposure to the policy are affected more negatively. Economically, a one-standard-deviation increase in exposure to the policy reduces real investment by 0.29%, sales growth by 2.20%, and net profit by 0.23%. Correspondingly, the firm also increases leverage by 0.21%.

One challenge to our empirical design is the possibility of time-varying, firm-specific shocks that are correlated with our measures of policy exposure. We overcome this challenge by running dynamic regressions of firm investment to obtain a time series of estimated quarterly coefficients of policy exposure. For all our regressions, we find that (i) the estimated coefficients are statistically insignificant in the pre-policy period, which suggests a parallel pre-policy trend, (ii) clear break during the policy period. This evidence supports our empirical design for estimating the causal effect of three red-line policy.

[Aggregate implication] Our estimated spillover effects are significant in aggregate. Following Mian and Sufi (2012), we conduct a conservative back-of-envelope calculation for the overall investment decline that can be attributed to the spillover effect of the three-red-line policy, Under the identifying assumption that firms with very exposures were unaffected by the three red-line policy. We find that our estimation accounts for 42.31% of the total investment decline during 2020Q4-2022Q3. Considering this is a period with COVID lockdowns, our estimated spillover effect is economically important.

[Model] What explains our results? We hypothesize that the spillover effects work through the production networks. As the policy forced the real estate firms to decrease leverage, non-real estate firms will be negatively affected because for those in the upstream or downstream sectors of the real estate, their economic activity will be affected through outstanding trade credit with problematic real estate developers, which encountered difficult to be repaid when the three red-line policy was implemented. Indeed, we find that sectors closer to the real estate in the production network or more relying on external financing were affected more in terms of investment. Within these sectors, firms advancing more trade credit to the real estate suffered more.

In our work-in-progress, we will provide a simple theoretical framework to rationalize the documented empirical results. We also work to estimate the spillover effects on the regional economy.

Our paper has important policy implications, especially on the spillover effects of the real estate sector on the economy. Given its tight connection to other sectors, policies on the real estate sector can create significant effects on other sectors. Failing to internalize such spillover effect might render the effectiveness of policies and create unintended consequences on the whole economy.

Literature Review Our paper contributes to several strands of the literature. First, our paper belongs to the literature that studies the importance of the real estate sector for the Chinese macroeconomy including Fang, Gu, Xiong, and Zhou (2016), Chen and Wen (2017), Glaeser, Huang, Ma, and Shleifer (2017), Rogoff and Yang (2022), Xiong (2023). Different from those papers, we study the spillover effects of the three-red-line policy to other sectors in the production network. A related paper is Gu (2023) which also studies the effect of the same policy. But his focus is on the real estate firms while we look at non-real estate firms.

Second, our paper is related to the literature on shock transmission through production networks. Di Giovanni and Hale (2022), Lane (2022), and Balboni, Boehm, and Waseem (2023). We focus on a specific policy shock in the real estate sector. Instead of focusing on the input-output channel as the literature emphasizes, this paper focusing on the trade credit channel through which disruptions in the real estate sector affect its upstream and downstream firms.

Last, our paper is related to the Literature on the effects of housing market regulations. There is extensive literature on the role of housing market regulations on the household sector, such as Greenwald (2018), Berger, Turner, and Zwick (2020), Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, and Yao (2017), and DeFusco, Johnson, and Mondragon (2020) focus on the household sector for the U.S. economy, and Du and Zhang (2015), Deng, Liao, Yu, and Zhang (2022) and Chen, Wang, Xu, and Zha (2020) for the Chinese economy. Another strand of this literature focuses on the regulations on financial institutions, including Jeske, Krueger, and Mitman (2013), Di Maggio and Kermani (2017) and Favara and Imbs (2015). Different from the above paper, this paper is firs to explore the effects of regulations on the leverage of real estate developers.

This paper is structured as follows. Section 2 provides the institutional background for the three red-line policy. In Section 4 and 4.3, we describe the empirical strategy and the data, respectively. Section 5 discusses the main empirical results. Section 6.2 provides evidence on the transmission mechanism of the three red-line policy. Section 7 concludes.

2 Institutional Background

In China, there are 99544 real estate firms, of which 112 are listed in the A-share market and 267 are listed in the H-share market in 2022. The market capitalization of listed A-share RE firms is 1.5 trillion RMB, roughly 2% of the Chinese A-share market. The real estate firm plays an important role in driving Chinese growth. Meanwhile, they are highly leveraged and tightly connected to other sectors. As a result, any policy that affects the real estate sector inevitably spills over to other sectors and hence the whole macroeconomy.

The Three Red Lines (TRL) policy was the first important regulatory policy for the real estate sector. It was proposed on August 20, 2020, when the Ministry of Housing and Urban-Rural Development and the PBOC held a symposium with representative real estate constructors in China. The regulators were concerned about the highly indebted property-development sector in China and thus required those firms to meet certain requirements relating to the ratio of debt to cash, equity, and assets. Specifically, there were three requirements for the real estate firms: 1) liabilities should not exceed 70 percent of assets (excluding advance proceeds from projects sold on contract); 2) net debt should not be greater than 100 percent equity; 3) money reserves must be at least 100 percent of short-term debt.[1]

Depending on the number of rules violated, the real estate firms can be grouped into four categories: red category (three rules are violated); orange category (two rules violated); yellow category (one rule violated), and green category (no rule violated). Violating those regulations has consequences for firms to take further leverage. For the most levered firms, the red category, they are not allowed to take any liabilities with interest. For the other categories, there will be certain restrictions on the annual growth rate of the liabilities with interest. The caps are 5%, 10%, and 15% respectively for the orange, yellow, and green real estate firms.

The three-red-line policy affects most real estate firms in China. At the end of 2020 Q2, there were 209 listed real estate firms in China (A share and H share markets combined). Based on their balance sheet information in 2020 Q2, we grouped them into four categories following the

[1] See https://www.gsm.pku.edu.cn/thought_leadership/info/1007/2273.htm.

Table 1 THE IMPACT OF THREE RED LINES POLICY ON REAL ESTATE FIRMS

# of Violation	H share	A share	Combined	Percentage
0	3	9	12	6
1	39	45	84	40
2	19	17	36	17
3	46	31	77	37
Total	107	102	209	100
	H share	A share	Combined	Percentage
1^{st} Line Violation	56	46	102	49
2^{nd} Line Violation	55	33	88	42
3^{rd}Line Violation	104	93	197	94

NOTE. The calculation is based on the balance sheet information of 209 listed real estate firms in 2020 Q2.

requirement of the policy in Table 1. 77 of the listed real estate firms are red firms, 36 are orange, 84 yellow, and 12 are green. Moreover, most firms violate both the first line and the third line.

3 A Simple Theoretical Framework

We consider a simple static two-sector model to guide our empirical analysis. Sector 1 is the real estate sector and sector 2 is the non-real estate sector. The spillover from sectors 1 to 2 is through the production network and trade credit.

Real estate sector. Firms in the real estate sector, i.e., sector 1, use capital k_1 and intermediate goods x_1 (produced by the non-real estate sector, i.e., sector 2) to produce the real estate output y_1.

$$y_1 = k_1^{\alpha_1} x_1^{\beta_1} \tag{1}$$

where $\alpha_1 \geq 0$ and $\beta_1 \geq 0$ are parameters with $\alpha_1 + \beta_1 < 1$.

Real estate firms need to finance capital and intermediate goods purchased through intra-period bank loans before production. They can choose the fraction of intermediate goods payments paid in advance. This assumption captures the use of trade credit between the non-real estate and real estate sectors. To capture the dominant role of real estate sectors in the economy, we assume that real estate firms choose $\gamma \in [0,1]$ fraction of intermediate good purchases paid after the production at a cost $c(\gamma)$ per transaction with $c'(\cdot) \geq 0$ and $c''(\cdot) \geq 0$. The cost function captures the monitoring and reputation costs as in Cun, Quadrini, Sun, and Xia (2022).

To capture the effects of the "three-red lines" policy, we assume that the total amount of external borrowing cannot exceed ϕ, with a lower ϕ capturing a tighter leverage constraint.

$$Rk_1 + (1-\gamma)p_2x_1 \leq \phi \tag{2}$$

where R is the gross interest rate and p_2 is the price of intermediate (non-real estate) goods.

Facing the financial constraint (2), real estate firms choose capital k_1, intermediate goods x_1, and the share of trade credit γ to maximize their profits π_1 as follows.

$$\pi_1 = p_1y_1 - Rk_1 - p_2x_1[1 + c(\gamma)] \tag{3}$$

where p_1 is the price of real estate goods and real state firms take it as given.

Non-real estate sector. Firms in the non-real estate sector, i.e., sector 2, use capital k_2 and labor l_2 to produce the non-real estate output y_2.

$$y_2 = k_2^{\alpha_2} l_2^{\beta_2} \tag{4}$$

where $\alpha_2 \geq 0$ and $\beta_2 \geq 0$ are parameters with $\alpha_2 + \beta_2 = 1$.

We assume that non-real estate firms use the pre-paid sales from the real estate firms $(1-\gamma)p_2x_1$ to finance capital Rk_2 and wage bills wl_2, given by

$$(1-\gamma)p_2x_1 \geq wl_2 + Rk_2 \tag{5}$$

where w is the wage rate. We assume that the financial constraint binds in equilibrium.

Facing the financial constraint (5), non-real estate firms choose capital k_2 and labor l_2 to maximize their profits π_2 given by

$$\pi_2 = p_2y_2 - Rk_2 - wl_2 \tag{6}$$

Exposure to the real estate sector. We impose the following condition to capture the ex-ante linkage between real and non-real estate sectors.

$$x_1 = my_2 \tag{7}$$

where $m \in (0,1)$ is the fraction of intermediate goods supplied from non-real estate to the real estate sector. Notice that m captures the production network linkage between the two sectors. Condition (7) is also the market clearing condition for the intermediate goods.

Equilibrium. Given the exogenous prices $\{p_1, R, w\}$, a competitive equilibrium consists of an allocation $\{k_1, x_1, \gamma, k_2, l_2, y_1, y_2\}$ such that (1) firms in the real estate and non-real estate sectors maximize their profits and are subject to respective constraints; (2) production functions (1) and (4) are satisfied, and (3) the intermediate goods market (7) clears.

In this simple framework, the effects of the "three red lines" policy can be modeled as a lower ϕ. We are interested in how this shock affects both the real estate and non-real estate sectors.

Proposition 1. *A leverage constraint shock (a lower ϕ) lowers activities in both the real estate and non-real estate sectors.*

1. *Real estate firms reduce their demand for capital and intermediate goods but increase their use of trade credit. Real estate output production also falls. Formally, we have* $\frac{d\gamma}{d\phi} < 0, \frac{d\log y_1}{d\phi} > 0, \frac{d\log k_1}{d\phi} > 0, \frac{d\log x_1}{d\phi} > 0.$

2. *Non-real estate firms also reduce their demand for capital and labor. Non-real estate output falls. Formally, we have* $\frac{d\log y_2}{d\phi} > 0, \frac{d\log k_2}{d\phi} > 0, \frac{d\log l_2}{d\phi} > 0.$

Proof. See Appendix A. □

Direct effects of the policy on RE firms. A tighter leverage constraint (a lower ϕ) reduces the intra-period loans available for real estate firms to finance their working capital. As a result, they reduce demand for capital and intermediate goods, which lowers the real estate output. Real estate firms also have an incentive to increase the use of trade credit because it lowers the amount of pre-paid intermediate goods purchases and reduces the effects of a tighter leverage constraint.

Spillover effects of the policy on non-RE firms. Non-real estate firms' production is indirectly affected by the regulatory policy on real estate firms because of two channels. One is through a lower intermediate good demand from the real estate sector $p_2 x_1$. The other is through a higher use of trade credit γ or a lower amount of pre-paid intermediate goods purchase. Both channels work through the binding financial constraint (5).

Identification of the spillover effects. To identify the spillover effects of the "three-red lines" policy, we introduce the parameter m to capture the production linkage between the two sectors. We then study the implication of different m on the response of non-real estate firms to the leverage constraint shock, i.e., the cross-derivative $\frac{\partial}{\partial m}\left(\frac{\partial \log y_2}{\partial \phi}\right)$. It is in general challenging to sign the cross-derivative analytically. The following proposition provides an analytical solution with a linear cost function assumption.

Proposition 2. *With a linear cost function, i.e. $c''(\cdot) = 0$, we have the following analytical results. Non-real estate firms closer to the real estate sector (i.e., a higher m) are more affected by the leverage constraint shock. Formally, we have* $\frac{\partial}{\partial m}\left(\frac{\partial \log y_2}{\partial \phi}\right) = \frac{\partial}{\partial m}\left(\frac{\partial \log k_2}{\partial \phi}\right) > 0.$

Exposure variable construction. The above proposition motivates the construction of our exposure measure variables in the following section. We need two pieces of information. One captures the effect of leverage shocks on real estate sectors, i.e., ϕ. The other captures the production linkage between the real and non-real estate sectors, i.e., m. Intuitively, the spillover effect is larger with a higher m, i.e. two non-real estate firms experience different sizes of spillover effects due to their production linkage to the real estate sectors. As the policy generates heterogeneous effects on real estate firms whose spillover effects might be different, we construct the exposure variable using variations in both ϕ and m.

4 Identification, Empirical Strategy and and Data

4.1 Identification

The three-red-line policy arguably affects the real estate sector directly. Even if a real estate firm was tagged as green, its liability (with interest) growth is capped at 15% by the regulation. Because real estate firms are highly leveraged, the policy is very effective in altering their financial and investment decisions. In our model, the effect is captured by a lower ϕ. Non-real estate firms linked to the real estate sector are also affected by the policy due to their production linkage to the real estate sector. This is captured by the m parameter in our model. Motivated by our model, we construct a firm-level *exposure* measure to identify the spillover effect of the real estate policy on non-real estate firms.

$$\text{expo}_i = \frac{1}{H}\sum_{h=1}^{H} \text{corr}_{i,h} * N_h \tag{8}$$

where expo_i is our exposure variable for non-real estate firm i, N_h is the number of violations of the three red-line regulations for real estate firm h as of August 20, 2020, $\text{corr}_{i,h}$ is the correlation between non-real estate firm i and the real estate firm h, and H is the total number of listed real estate firms in both A and H markets.

The construction of our exposure variable closely follows our model intuition and can be interpreted as a "Bartik" type of instrument. The policy announcement on August 20, 2020, generated an unexpected aggregate shock to the real estate sector. Cross-sectionally, different real estate firms are affected differently, as captured by the number of violations N_h empirically and a lower value of ϕ shock theoretically. The size of spillover effects are captured by the degree of production linkage m in the model. Empirically, we use the stock return as a proxy, assuming that the stock market has reflected the needed information for the production relationship between the real and non-real estate firms. To isolate the policy's impact, we use daily stock returns between 2010 and

Table 2 Correlates of Exposure Measures

	Coefficient	t-stats	R^2 Decomposition	Obs
Size	0.0232***	8.67	0.08	2567
Leverage	-0.0003	-0.22	0.01	2567
ROA	-0.0033	-0.95	0.01	2567
SOE	0.0591***	11.91	0.08	2567
Sales growth	-0.0007	-1.09	0	2567
Cash flow	-0.0010	-0.36	0.01	2567
EBIT	0.0879	0.75	0.01	2567

Note. The table presents the potential correlates of the exposure measure using linear regression of the exposure measure on firm characteristics including firm size, leverage, ROA, state ownership, cash flow, and EBIT. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

2019, i.e., *pre-policy period*, to calculate the correlation.[2]

Identifying the policy's spillover effects on non-real estate sectors relies on the exogeneity of the exposure measure. This is likely to hold because the real estate regulatory policy was unexpected and unprecedented. The stock return correlation is estimated using the pre-policy period. Together, the exposure variable captures the size of spillover effects from the real estate sector to non-real estate firms.

One may worry about the correlation between our exposure measure and other firm-level characteristics. Table 2 presents their relationship. We include important potential correlates such as size, leverage, return on assets (ROA), state ownership (SOE), sales growth, cash flow, and earnings (EBIT). We also show the additive Shorrocks-Shapley decomposition of the overall R^2 for each variable, which reflects its relative importance in explaining our exposure variable. We find that only firm size and state ownership are statistically positive. Moreover, their contribution in the overall R^2 is the highest (8%) compared with other variables (0 to 1%). Notably, none of those variables has a high R^2, which suggests that our exposure variable indeed captures different information beyond those firm-level variables. Nevertheless, we carefully control the impact of those firm-level variables, especially size and state ownership, in the following specifications.

4.2 Empirical Specification

We estimate the real spillover effects of the "three-red lines" policy on non-real estate firms in a 12-quarter window through a difference-in-differences specification.

$$y_{it} = \beta * \text{Expo}_i \times \text{Post}_t + \text{Control}_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \tag{9}$$

[2] We also check the robustness of our results using daily abnormal stock returns to construct the correlation. The results are consistent and available upon request.

where y_{it} is the corporate investment (Capex/Asset), sales growth, EBIT, leverage, and trade credit respectively. Expo_i is our exposure measure to identify the policy's spillover effect constructed in (8). We standardize the exposure measure for ease of exposition. Post_t equals one for quarters after 2020 Q4. Control_{it} includes standard controls such as the firm size, ROA, leverage, Tobin's Q, and cash flow. In addition to firm fixed effects, we include interactive fixed effects between different size bins and time to control for the different trend growth of large and small firms, between state ownership and time to control for the different trend growth of state and private firms, and between industry and time to control for the different time trends across industries. To control for the contemporaneous effect of COVID-19-related news, we add an interactive fixed effect between a COVID-19 CAR (cumulative abnormal return) and time, where the COVID-19 CAR is estimated in a 7-day window around the Wuhan lockdown. The idea is to use the stock return response during the first COVID-19 lockdown policy as a proxy to capture the sensitivity of firms to COVID-19-related news. Standard errors are clustered at the firm level.

Our key interest is the coefficient β, which captures the spillover effects of the three-red-line policy on the non-real estate firms. Because the policy's spillover effects take time to materialize, we estimate equation (9) in the quarterly frequency data at [-4Q, 8Q].

4.3 Data

We collect the stock return and balance sheet information data from China Stock Market & Accounting Research (CSMAR). We exclude firms in the finance and utility sectors as conventional. We require firms to satisfy the following conditions: 1) they have to be listed at least 1 year before 2020Q3; 2) they need to have information for 2 quarters before or after the policy shock period; 3) their stock status should be labeled as normal (e.g., exclude *ST). Our sample thus consists of 2,609 non-real estate firms. The distribution of the sample is in Appendix Table A1.

We focus on several dependent variables in our regression. The corporate investment is constructed using the past four quarters' total capital expenditure divided by the book value of total assets at the last quarter's end. Sales growth is constructed as the firm's year-over-year sales growth rate. EBIT is constructed as net income plus interest expense and taxes. Leverage is the book value of debt divided by the book value of total assets at quarter end. TCA is the sum of firm's account receivables and advance payments normalized by total asset, which characterizes the trade credit this firm extends to her downstream customers. We also construct important firm-level control variables, such as firm size (the natural logarithm of total assets), Tobin's Q (the book value of total assets minus the book value of equity plus the market value of equity scaled by the book value of total assets at quarter end), cash flows (the income before extraordinary items plus depreciation and amortization divided by the book value of assets at quarter end) and ROA (the net income

Table 3 SUMMARY STATISTICS

	Obs	Mean	Std.	25%	Median	75%
Exposure	2,567	0.389	0.114	0.32	0.411	0.479
Capex/Asset (%)	33,404	4.716	5.467	1.374	3.331	6.591
Tobin's Q	33,404	2.33	1.976	1.268	1.758	2.635
Cash Flow (%)	33,404	6.431	9.998	3.09	6.261	10.261
Log (Asset)	33,404	22.423	1.322	21.488	22.233	23.129
Leverage	33,404	3.313	3.705	1.773	2.359	3.607
ROA (%)	33,404	2.63	5.535	0.551	2	4.462
Sales Growth (%)	33,404	17.644	46.862	-6.469	9.844	30.693
EBIT (%)	33,404	3.845	6.533	1.051	2.869	5.79
TCA (%)	33,404	16.953	12.540	7.750	14.434	22.985
TCL (%)	33,404	34.067	18.201	20.008	31.448	45.403
TCN (%)	33,404	-17.114	19.492	-28.928	-14.780	-4.135

NOTE. Exposure is constructed as in equation (8). Capex/Asset is the capital expenditure divided by the lagged total assets. Tobin's Q is the book value of total assets minus the book value of equity plus the market value of equity scaled by the book value of total assets at the end of the quarter. Cash Flow is the income before extraordinary items plus depreciation and amortization divided by the book value of assets, measured at the end of the quarter. Leverage is The book value of debt divided by the book value of total assets measured at the end of the quarter. ROA is net income divided by the book value of lagged total assets. Sales Growth is a firm's Year-over-Year sales growth rate. EBIT is earnings before interest and taxes which is calculated as net income plus interest expense and taxes. TCA is constructed as the sum of account receivables and advance payments divided by total asset. TCL is constructed as the sum of account payables and advance receipts divided by total liability. TCN is the difference between TCA and TCL.

divided by the book value of total assets at quarter end). TCN is the difference between TCA and TCL, where TCL is defined as the sum of a firm's account payables and advance receipts divided by this firm's total liability. The summary statistics for those variables are provided in Table 3.

5 Empirical Results

Table 4 presents our estimation of the spillover effects for the three-red-line policy on non-real estate firms. Consistent with the theoretical model, the spillover effect is negative, statically significant, and economically sizable. Using column (1) as an example, a non-real estate firm with one standard deviation higher exposure variable experiences a lower corporate investment of 0.43% on average during 8 quarters after the three-red-line policy shock. This effect is economically significant, given that the average corporate investment is 4.72% in the sample. In columns (2) and (3), we add into the regression additional interactive fixed effects and control variables. The results are robust, with only a slight change in the estimated coefficient.

In columns (4) and (5), we estimate the policy's spillover effects in terms of sales growth and profitability. Consistent with the negative spillover effects on corporate investment, both sales growth and profit are lower for firms closer to the real estate sector. A one-standard-deviation

Table 4 SPILLOVER EFFECTS OF THREE RED LINES POLICY ON NON-REAL ESTATE FIRMS: DIFFERENCE-IN-DIFFERENCES ESTIMATION

	Capex/Asset			Sales (%)	EBIT (%)	Leverage (%)	TCA (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Expo × Post	-0.429***	-0.432***	-0.309***	-2.306**	-0.362***	-0.692***	0.315***
	(-4.83)	(-4.73)	(-3.49)	(-2.10)	(-3.19)	(-3.72)	(2.93)
Size			1.191***	43.706***	-0.235	9.553***	0.563
			(3.10)	(8.61)	(-0.15)	(9.48)	(0.83)
ROA			-0.006	2.393***		-0.131***	0.077***
			(-0.75)	(15.43)		(-6.04)	(6.50)
Leverage			0.041***	1.182***	-0.065***		0.045***
			(5.80)	(12.03)	(-3.77)		(3.93)
Tobin's Q			0.214***	1.586**	1.214***	0.371***	0.080
			(4.41)	(2.27)	(8.15)	(2.96)	(1.20)
Cash Flow			0.031***	0.977***		-0.265***	0.015
			(4.06)	(7.34)		(-12.94)	(1.27)
TCN			-0.006	-0.332***	-0.011	0.132***	0.104***
			(-1.46)	(-6.27)	(-1.64)	(13.05)	(13.11)
Stock FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size×Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SOE×Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry×Time	No	Yes	Yes	Yes	Yes	Yes	Yes
Covid×Time	No	No	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.69	0.69	0.70	0.42	0.44	0.92	0.92
Obs	33,552	33,552	33,404	33,404	33,404	33,404	33,404

NOTE. The table reports the real impact of the three red lines policy on firm investment, sales growth, profitability, and leverage. The sample period is from 2019 Q3 to 2022 Q3 and includes 2,609 A-share listed firms. The *Expo* measure is constructed as in equation (8), and normalized by its standard deviation. The dummy *Post* equals one from 2020 Q4. *Capex/Asset* is measured as the capital expenditure (in trailing 12 months) normalized by total assets of the last quarter end. Sales Growth is measured as year-over-year sales growth at each quarter end. *EBIT* is measured as net income plus interest and tax normalized by the total assets of the last quarter end. *TCA* is constructed as the sum of account receivables and advance payments divided by total asset. *TCL* is constructed as the sum of account payables and advance receipts divided by total liability. *TCN* is the difference between *TCA* and *TCL*. *Size* measures the average total asset growth rate over 12 quarters before 2020 Q3. *Covid* is the cumulative abnormal return (CAR [-10, 9]) centered at the outbreak of Covid-19 in China (Wuhan lockdown) on January 23, 2020, based on the Fama-French 3-factor model, estimated using a 126-day window. Standard errors are clustered by firm and t-statistics are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

increase in the exposure reduces sales growth by 2.31% and corporate profit by 0.36% during 8 quarters after the policy shock. This again is consistent with our theoretical predictions.

With a negative spillover effect on the non-real estate firms, how do they respond regarding their financial decisions? Column (6) suggests that firms more exposed to the real estate sector have a lower leverage. This is in line with the transmission mechanism in our model. Recall that a tighter regulatory policy on the real estate sector results in a lower intermediate good demand on the non-real estate good production and a higher use of trade credit in the transactions between real and non-real estate sectors, which lowers the incentive to increase leverage. In Table A2, we provide consistent evidence that both the interest and debt are lower for non-real estate firms more exposed to the real estate sectors. Those firms lower their credit demand facing the negative spillover effects. Although we do not have detailed trade credit transaction-level data between real and non-real estate firms, we do observe a higher share of trade credit on the asset side for non-real estate firms (account receivables) if they are more exposed to the real estate sector in column (7).

Pre-trend assumption. We test the pre-trend assumption of our difference-in-differences specification (9) by estimating the policy's dynamic effects on non-real estate firms in Figure 1. We find that the policy did not generate a significant differential effect on the high and low-exposed firms before the policy shock. The negative (positive) differential effect on corporate investment (trade credit) between high and low-exposed firms only shows up post-policy and lasts for eight quarters.

Aggregate impact of the spillover effects We have estimated a significant negative spillover effect of the policy shock on corporate investment through a difference-in-differences estimation that compares the differential impact of high vs. low-exposed firms. But how large is the aggregate effect of the policy on non-real estate firms? Answering this question is important yet challenging.

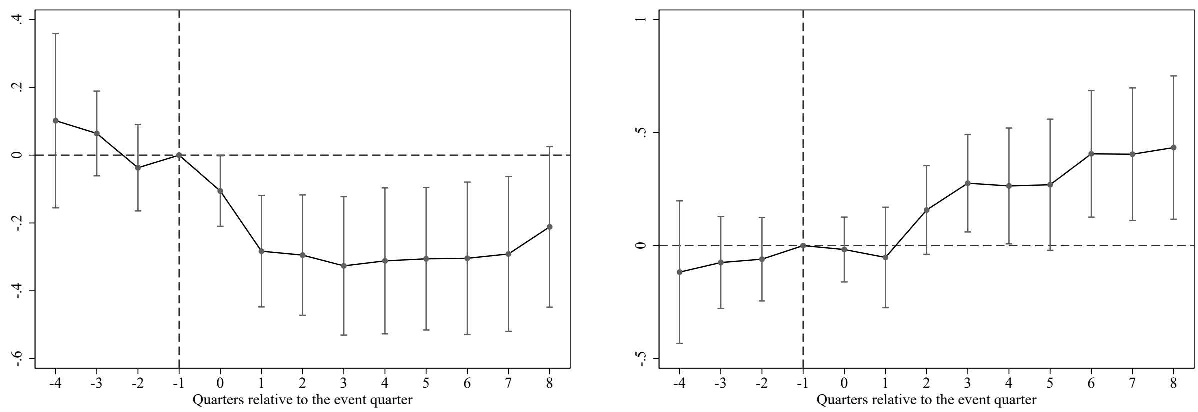
We make progress following Mian and Sufi (2012) which transfers the difference-in-differences estimation into an aggregate estimation through a back-of-envelope calculation under some assumption. The first step is to divide non-real estate firms into deciles based on the exposure variable. Treat the lowest decile as the control group. Multiply the estimated difference-in-difference coefficient β from equation (9) by the difference between each decile's exposure and the control group's exposure. This gives the estimated differential effects of the policy on corporate investment for different deciles. Assume that the low-exposed non-real estate firms (i.e., the control group) are not affected by the policy. One can calculate the aggregate spillover effects from the policy by converting the forgoing estimate (multiplied by lagged assets) into the RMB values and summing up across all deciles for each quarter. This gives an estimate of the cumulative decline of non-real estate corporate investment at 390.54 billion RMB.

Notice that the 390.54 billion RMB can be causally attributed to the three-red-line policy due to the nature of the difference-in-differences estimation. It should also be considered as a lower-bound estimation. This is because the back-of-envelope calculation assumes a zero impact on the control group while the policy still caps the leverage growth of non-violating real state firms (that generate a zero exposure variable to non-real firms from them) at 15%.

Is the 390.54 billion RMB a large number compared to the overall investment behavior in China? The Chinese economy is in a downward trend trajectory during the same period, how much of the overall decline can be attributed to the policy's spillover effect? To answer these questions, we need to estimate the overall investment dynamics in the same period, which serves as a counterfactual benchmark. We take a conservative approach using the average quarterly growth

Figure 1 DYNAMICS EFFECTS ON CORPORATE INVESTMENT AND TRADE CREDIT

Panel A: Corporate Investment | Panel B: Trade Credit to Customers



NOTE. The figure plots the coefficients $\{\beta_s\}_{-4}^{8}$ along with the 95 confidence intervals based on the difference-in-differences estimation $y_{it} = \alpha + \sum_{s=-4}^{8} \beta_s * \text{Expo}_i * 1_{t+s} + \gamma * \text{Control}_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$, where y_{it} is corporate investment in panel A and trade credit in panel B.

rate of corporate investment (3.84%) for the same non-RE firms during 2017Q3-2020Q3, the pre-policy period, as the counterfactual trend growth rate of corporate investment during 20020Q4-2022Q3. The difference between the actual and the counterfactual investment growth rate explains the overall investment decline at 923.118 billion RMB, which can be attributed to many factors including the regulatory policy's spillover. Based on this estimation, the total drop in investment due to the three-red-line policy is 42.31% (=390.536/923.118) of the overall investment decline in the same period. This is a sizable number considering that our estimation is a lower bound.

6 Inspecting the Economic Mechanism

In this section, we take additional tests to unpack our estimated spillover effects. Our first approach is based on a two-stage estimation that connects the responses of real and non-real estate firms. The second approach conducts heterogeneity analysis to further support our hypothesized economic mechanism in the model and empirical specification.

6.1 A Two-Stage Estimation

The transmission of the "three-red lines" policy on non-real estate firms is through the real estate firms. Our empirical identification relies on the construction of the exposure variable which incorporates the information on the number of policy violations for real estate firms. However, this measure does not capture the policy's impact on the real estate firms and thus the corresponding channels that affect non-real estate firms. To further unpack the economic mechanism, we consider a two-stage estimation for the spillover effects with the first stage on the policy's impact on the *real estate* firms and the second stage on the corresponding impact on *non-real estate* firms.

$$\text{First Stage:} \quad y_{hT} = \sum_{s=-5}^{5} \sum_{k=1}^{3} \beta_s^k \times 1_{\text{Violate } k^{th} \text{ line}} * 1_{T=s} + \Gamma Z_{hT} + \varepsilon_{hT} \tag{10}$$

where y_{hT} is the interest-bearing debt, inventory growth, or trade credit usage (TCL) for real estate firm h at time T. Interest-bearing debt is the sum of real estate interest-bearing debt normalized by total liability. Inventory growth is the annual growth rate of the real estate firm's inventory. Trade credit usage is constructed similarly to the variable *TCL*, which is the sum of account payables and advance receipts normalized by the firm's total liability. Because we conduct our regression analysis of equation (10) at semi-annual frequency due to data availability, we use different time notations T to denote semi-annual time frequency. Indicator function $1_{\text{Violate } k^{th} \text{ line}}$ characterizes the status of a real estate firm that violates the k^{th} red line. Control variables Z_{ht} include the firm's size, Tobin's Q, cash flow, ROA, and leverage, all of these variables are constructed in the same way as in the non-real estate firms case. One potential concern of our first-stage regression is that the status of red line violations could be correlated with our dependent variable (e.g. interest-bearing debt, inventory growth, trade credit usage), leading to omitted variable estimation bias. To alleviate this bias, we first conduct a cross-section multinomial logit regression on $1_{\text{Violate } k^{th} \text{ line}}$ dummy with time fixing at the second half year of 2020, we control the above mentioned firm-level characteristics with one-half-year lag. We collect the residual terms from the multinomial logit regression which, by design, correlate with $1_{\text{Violate } k^{th} \text{ line}}$ dummy but uncorrelated with other control variables. We then use the interaction of multinomial logit residual term and time dummy as our additional control variable for the first stage regression to address the omitted variable bias. In addition to the above control variables, similar to the non-real estate firm investment regression, we further control firm fixed effect along with multiple time-interacted fixed effects on *Size Growth*, *Covid-CAR*, firm *Over-supply*, and *Listing Market*. Variables on firm *Over-supply* control the pre-shock degree of real estate firm expansion, which is measured as the annual growth rate of inventory. Standard errors are clustered at the real estate firm level.

In the second stage, we first construct a predicted exposure variable for non-real estate firms using the predicted value from the first-stage estimation.

$$\text{ex}\hat{\text{p}}\text{o}_{it} = \frac{1}{H} \sum_{h=1}^{H} \text{corr}_{i,h} * \hat{y}_{ht} \tag{11}$$

where $\hat{y}_{ht}$ is the predicted value from the first-stage estimation (10). Notice the key difference between the second-stage exposure variable in equation (11) and our baseline exposure variable in equation (8) is that the second-stage exposure incorporates the specific transmission channel that the three-red lines policy works to affect the non-real estate firms.

Using different second-stage exposure variables based on the first-stage predicted variables, we estimate the following difference-in-differences specification.

$$I_{it} = \sum_{s=-5}^{5} \beta_s \times \text{exp}\hat{\text{o}}_{it-1} * 1_{t+s} + \Gamma Z_{it} + \varepsilon_{it} \tag{12}$$

where the specification is similar to our baseline specification (9) except for the exposure variable $\text{exp}\hat{\text{o}}_{it-1}$. Firstly, at each half-year, we get our estimated exposure measure $\widehat{\text{expo}}_{it}$, then use it to predict the next quarter's non-real estate investment. Secondly, the estimated exposure measure in the second stage regression is time-varying, which captures the dynamic effect of three red line shocks on real estate firms via various channels including interest-bearing debt, inventory growth, or trade credit.

[ADD More explanation]

6.2 Heterogeneity Analysis

The economic transmission of the documented spillover effects from the three-red-line policy on non-real estate firms comes from two parts, one through the production network and the other through the trade credit channel. We provide additional evidence using a heterogeneity analysis. Specifically, we estimate the investment response to the three-red-line policy by different firm groups and we focus on three dimensions of firm heterogeneity including the upstream closeness to the real estate sector, external financing dependence, and ownership structure.

$$I_{it} = \alpha + \sum_{s=-4}^{8} \left(\sum_{g} \beta^{g}_{t+s} 1_{g \in G} \right) * \text{Expo}_i * 1_{t+s} + \Gamma Z_{it} + \varepsilon_{it} \tag{13}$$

where the specification is similar to the baseline specification (9) and the group indicator G is defined based on the firms' pre-policy characteristics.

Upstream closeness. We measure the upstream closeness using the sectoral-level information from the 2018 Input-Output table. For sector i, its upstream distance to the real estate is measured by $\text{Up}_i = \frac{y_{i,\text{RE}}}{\sum_k y_{i,k}}$, where y_{ik} is output supplied by sector i to sector k. We divide firms into two groups based on their upstream distance to the RE sector. Upstream high sectors include construction design, construction, construction materials, etc (see Figure A1).

External financing dependence. We construct the external financing dependence (EFD) measure

Table 5 THE EFFECTS OF THREE RED LINES POLICY ON REAL-ESTATE FIRMS

	Interest-Bearing Debt			Inventory Growth			Trade Credit Usage		
	$k=1$	$k=2$	$k=3$	$k=1$	$k=2$	$k=3$	$k=1$	$k=2$	$k=3$
$T=-5$	-0.687	-1.426	0.216	-0.318	0.694	-1.506	-0.551	-1.183	-3.897
	(-0.13)	(-0.25)	(0.04)	(-0.11)	(0.21)	(-0.52)	(-0.14)	(-0.25)	(-0.95)
$T=-4$	1.477	2.051	2.306	3.293	4.470	3.289	-1.553	-0.047	-2.767
	-0.39	(0.44)	(0.60)	(1.38)	(1.38)	(1.37)	(-0.52)	(-0.01)	(-0.89)
$T=-3$	0.903	3.333	1.671	-0.762	1.152	-0.982	-0.869	0.231	-1.649
	-0.26	(0.90)	(0.46)	(-0.42)	(0.41)	(-0.52)	(-0.38)	(0.10)	(-0.75)
$T=-1$	-0.948	-1.075	-2.997	-1.035	-1.538	-1.276	3.592	4.213	3.712
	(-0.47)	(-0.46)	(-1.47)	(-0.74)	(-0.86)	(-0.80)	(1.16)	(1.46)	(1.27)
$T=0$ (2020Q4)	-15.03*	-3.008	-17.09**	-5.343	-4.281	-8.008**	18.059***	10.57*	16.07***
	(-1.95)	(-0.45)	(-2.35)	(-1.54)	(-1.18)	(-2.28)	(2.79)	(1.70)	(2.80)
$T=+1$	-16.44**	-4.141	-18.86**	-1.924	-0.523	-4.958**	15.31***	9.902	15.37***
	(-2.02)	(-0.59)	(-2.43)	(-0.92)	(-0.20)	(-2.31)	(2.64)	(1.60)	(2.86)
$T=+2$	-25.34**	-12.55	-26.86***	-3.087	-3.080	-9.268***	21.15***	12.83*	18.03***
	(-2.49)	(-1.43)	(-2.97)	(-1.47)	(-1.25)	(-4.21)	(2.78)	(1.72)	(2.70)
$T=+3$	-19.84**	-7.766	-21.33**	-4.477**	-3.322	-8.893***	20.79**	13.90*	18.23***
	(-1.97)	(-0.86)	(-2.40)	(-2.23)	(-1.42)	(-3.85)	(2.57)	(1.77)	(2.62)
$T=+4$	-23.28**	-10.91	-25.25***	-1.332	-4.319*	-8.915***	21.30***	11.16	17.65**
	(-2.20)	(-1.15)	(-2.65)	(-0.58)	(-1.75)	(-3.84)	(2.85)	(1.44)	(2.58)
$T=+5$	-28.36***	-16.26**	-28.32***	-3.153	-6.163**	-10.27***	21.96***	10.45	16.15**
	(-3.08)	(-2.05)	(-3.40)	(-1.40)	(-2.44)	(-4.26)	(3.06)	(1.43)	(2.50)
Firm FE		Yes			Yes			Yes	
Size × Time		Yes			Yes			Yes	
Covid × Time		Yes			Yes			Yes	
Over-supply × Time		Yes			Yes			Yes	
HK × Time		Yes			Yes			Yes	
Adj-R2		0.78			0.26			0.78	
Obs		2,165			2,165			2,165	

NOTE. The table reports the first-stage regression results based on equation (10). The dependent variables are interest-bearing debt, inventory growth, and trade credit. Control variables include the firm's size, Tobin's Q, cash flow, ROA, and leverage. We omit them to save place. Standard errors are clustered by firm and t-statistics are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

following Rajan and Zingales (1998). A firm's dependence on external finance is defined as the ratio of capital expenditure minus cash flow from operations divided by capital expenditure. For each firm, we sum over the numerator and denominator for the past 10 years before dividing, then we choose the industry median as our final sectoral EFD measure.

State ownership. One unique feature of Chinese firms is the ownership structure. We group firms into private and state-owned firms and conduct the difference-in-differences estimation in . We find that our spillover effects are driven by private firms. State-owned firms, however, are not affected by the three-red-line policy.

Figure 2 presents the dynamic effects of the policy shock on the corporate investment of non-RE firms based on their distance to the RE sector. We find that our documented spillover effect is driven by the distance to the RE sector and thus the production networks. The spillover effects only show up in firms closer to RE sectors either upstream or downstream.

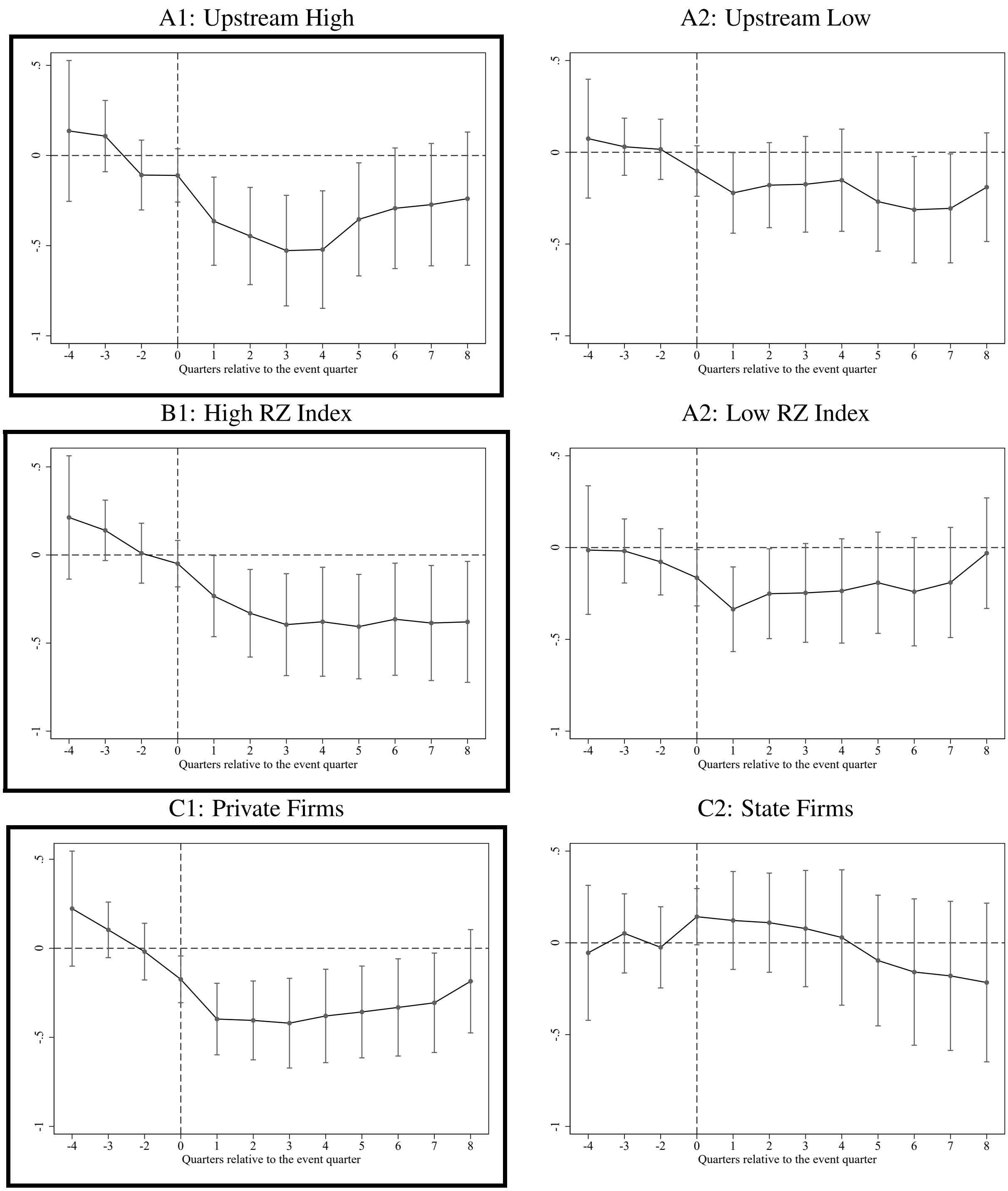
How to rationalize our results? We conjecture that when the RE sectors reduce leverage due to the policy they might affect non-RE firms through a trade credit channel. As the trade credit works

Table 6 THE EFFECTS OF THREE RED LINES POLICY ON NON-REAL-ESTATE FIRMS: SECOND-STAGE ESTIMATION

	Investment			TCA	TCL	TCN
	IBD Channel	Inventory Channel	TC Channel			
$T = -2$	-0.040	0.175	0.080	-0.020	-0.151	0.117
	(-0.75)	(0.34)	(1.15)	(-0.25)	(-1.17)	(0.80)
$T = 0$ (2020Q3)	-0.066*	0.011	0.015	0.162**	0.241	-0.117
	(-1.91)	(0.02)	(0.27)	(2.04)	(1.62)	(-0.73)
$T = +1$	-0.055	-1.419*	-0.183***	0.105	0.255*	-0.179
	(-1.21)	(-1.84)	(-2.98)	(1.37)	(1.92)	(-1.30)
$T = +2$	-0.022	-1.698**	-0.209***	0.163*	0.371**	-0.252*
	(-0.35)	(-2.21)	(-2.91)	(1.76)	(2.53)	(-1.71)
$T = +3$	0.052	-2.151	-0.196***	0.246***	0.415***	-0.195
	(0.55)	(-0.35)	(-2.59)	(2.64)	(2.98)	(-1.42)
$T = +4$	0.015	-3.339	-0.077	0.391***	0.563***	-0.238*
	(0.22)	(-0.41)	(-1.01)	(3.96)	(3.82)	(-1.68)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Size $\times$ Time	Yes	Yes	Yes	Yes	Yes	Yes
Covid $\times$ Time	Yes	Yes	Yes	Yes	Yes	Yes
Industry $\times$ Time	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.66	0.66	0.66	0.91	0.90	0.92
Obs	17,979	17,979	17,979	17,979	17,979	17,979

NOTE. The table reports the second-stage regression based on equation (11). The first three columns report regression results with non-real estate investment as the dependent variable. The *IBD*, *Inventory*, and *TC* channels correspond to using estimated exposure measure from the first stage regression results on *Interest-Bearing Debt*, *Inventory Growth*, and *Trade Credit Usage (TCL)*. *TCA* is constructed as the sum of account receivables and advance payments divided by total assets. *TCL* is constructed as the sum of account payables and advance receipts divided by total liability. *TCN* is the difference between *TCA* and *TCL*. Standard errors are clustered by firm and t-statistics are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Figure 2 Heterogeneity Analysis



NOTE. This figure estimates the difference-in-differences equation $I_{it} = \alpha + \sum_{s=-4}^{8}\left(\sum_g \beta_s^g 1_{g\in G}\right) * \mathrm{Expo}_i * 1_{t+s} + \Gamma Z_{it} + \varepsilon_{it}$ based on different firm groups. Panel A1 and A2 group firms based on the EFD measure as in Rajan and Zingales (1998) and display the coefficients $\{\beta_s^g\}_{-4}^{8}$ along with the 95 c.i. for EFD high and EFD low groups respectively.

through the production network, firms closer to the RE sector in the production network (upstream or downstream) are affected more. To test this hypothesis, we conduct a firm-level measure for net trade credit, i.e., $\mathrm{TC}_i \equiv \frac{\text{Account Receivables}+\text{Pre-paid Sales}-\text{Account Payables}}{\text{Asset}}$ as in Cun et al. (2022). We estimate our dynamic effects by grouping firms based on the production network distance and the net trade credit measure in Figure. Consistent with our prior, we find that only firms closer to the RE sector in the production network and with a higher net trade credit are affected more by the policy shock.

Our hypothesized mechanism works through a credit demand channel. When the three-red-lines policy hits the real estate, other sectors are negatively affected and thus reduce their credit demand. Notice that there might be a credit supply story—banks anticipate those firms closer to the real estate are more affected and thus rationally reduce their credit supply to those firms. We differentiate these two channels by investigating the policy effects on both interest rates and debt. The response of interest rates is the key to differentiating these two channels: lower credit demand reduces interest rates while lower credit supply increases interest rates. Table A2 presents the estimation results. Interest rates fall to the three-red-lines policy, more so for those closer to the real estate sector. Debt amount also falls, as suggested by both the credit supply and demand channel. The response of interest rates thus suggests that our documented effects are most likely driven by the credit demand channel as opposed to the credit supply channel.

7 Conclusion

In this paper, we study the spillover effect from real estate to non-real estate sectors by studying an important policy announcement in China, the three-red-line policy regulating real estate developers. We find that the three-red-line policy had unintended negative impacts on both financial markets and the real economy.

Our documented spillover effects are economically significant, which account for 42.32% of the aggregate investment decline during 2020Q4-2022Q3. The spillover effect transmits through a production network. Sectors closer to real estate either upstream or downstream experienced a sharper decline in investment. Moreover, firms with large trade credit exposure are more affected.

Our paper has important policy implications, which suggest an unintended consequence of regulatory policies. In ongoing work, we will provide a theoretical model to rationalize the empirical results. We also work on a regional-level exposure to study the regional real effects.

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Internet Appendix

'The Spillover Effects of Real Estate Sector'

(Intended for online publication only)

by K. Chen, H. Du, and C. Ma

November 2024

Table A1 FIRM DISTRIBUTION IN OUR SAMPLE

Year-Quarter	Time	# of firms
2019Q3	-4	2558
2019Q4	-3	2607
2020Q1	-2	2568
2020Q2	-1	2570
2020Q3	0	2567
2020Q4	1	2567
2021Q1	2	2567
2021Q2	3	2544
2021Q3	4	2573
2021Q4	5	2578
2022Q1	6	2579
2022Q2	7	2559
2022Q3	8	2567

Table A2 EFFECTS OF THREE RED LINES POLICY ON INTEREST RATES AND DEBT: DIFFERENCE-IN-DIFFERENCES ESTIMATION

	Interest Rate (%)		Debt/Liability (%)	
	(1)	(2)	(3)	(4)
Expo × Post	-0.125**	-0.136**	-1.121***	-0.461*
	(-2.01)	(-2.23)	(-4.41)	(-1.80)
Size		-0.388**		-1.961**
		(-2.13)		(-1.99)
ROA		-0.042***		-0.293***
		(-5.73)		(-9.66)
Leverage		0.088**		-3.244***
		(2.50)		(-8.00)
Tobin's Q		-0.063*		-0.207
		(-1.92)		(-1.25)
Cash Flow		0.014***		0.068***
		(2.93)		(2.87)
Firm FE	Yes	Yes	Yes	Yes
Size Growth × Time	Yes	Yes	Yes	Yes
Industry × Time	No	Yes	No	Yes
Covid CAR × Time	No	Yes	No	Yes
Adj. R^2	0.69	0.70	0.69	0.70
Obs	28,191	28,060	33,404	33,404

NOTE. The table reports the real impact of the three red lines policy on firm interest rates and debt amount. The sample period is from 2019 Q3 to 2022 Q3 and includes 2,609 A-share listed firms. The Expo measure is constructed as in equation (8) normalized by its standard deviation. The dummy Post equals one from 2020 Q4. Interest rates are measured as the interest expense divided by the average of short and long-term debt from the beginning to the end of the quarter. The debt amount is measured as the sum of short and long-term debt normalized by the total liability of the last quarter. Size growth measures the average total asset growth rate over 12 quarters before 2020 Q3. The Covid CAR is the cumulative abnormal return (CAR [-10, 9]) centered on the outbreak of Covid-19 in China (Wuhan lockdown) on January 23, 2020, based on the Fama-French 3-factor model, estimated using a 126-day window. Standard errors are clustered by firm and t-statistics are reported in parentheses. *,** and *** indicate statistical significance at the 10%, 5%, and 1% level.

Figure A1 UPSTREAM AND DOWNSTREAM

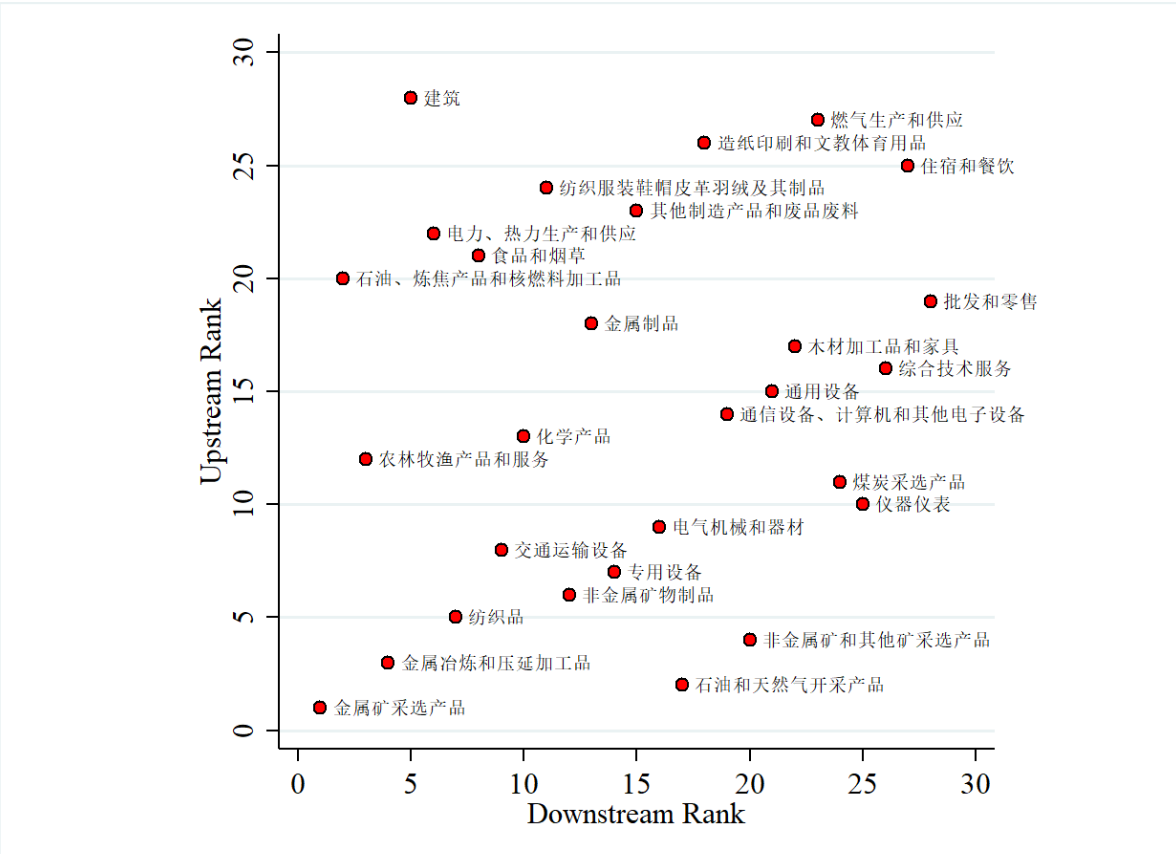
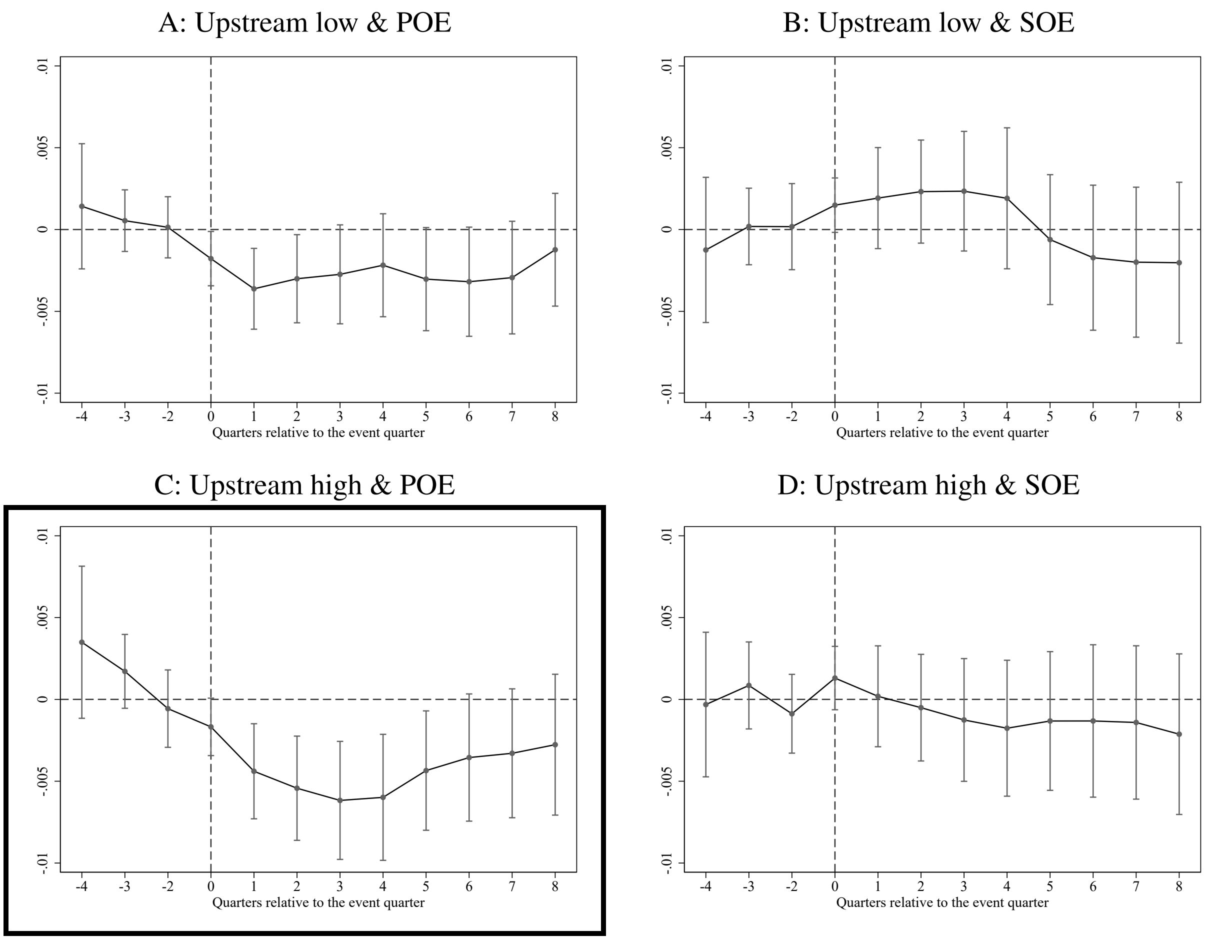
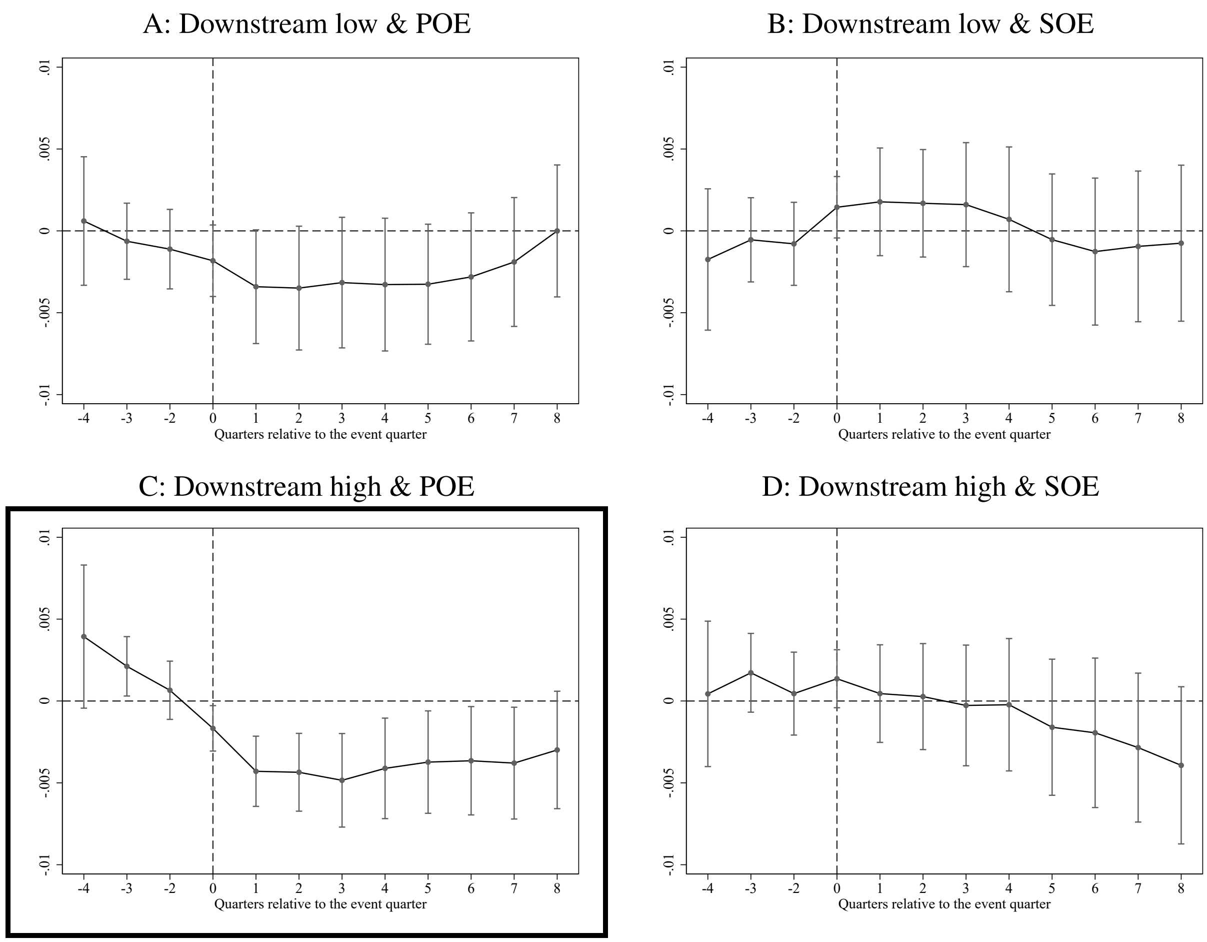


Figure A2 Upstream Distance and Ownership



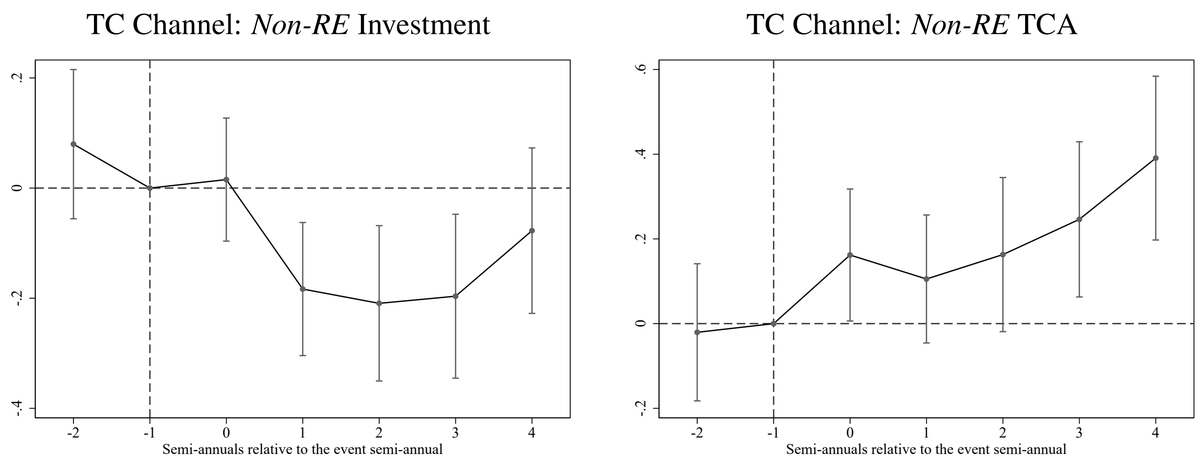
NOTE. This figure estimates the difference-in-differences equation $I_{it} = \alpha + \sum_{s=-4}^{8} \left(\sum_g \beta_s^g 1_{g\in G}\right) * \text{Expo}_i * 1_{t+s} + \Gamma Z_{it} + \varepsilon_{it}$ based on different firm groups. Panel A to D group firms based on the upstream distance to the RE sector and the ownership structure and display the coefficients $\{\beta_s^g\}_{-4}^{8}$ along with the 95 c.i. respectively.

Figure A3 Downstream Distance and Ownership



NOTE. This figure estimates the difference-in-differences equation $I_{it} = \alpha + \sum_{s=-4}^{8} \left(\sum_g \beta_s^g 1_{g \in G} \right) * \text{Expo}_i * 1_{t+s} + \Gamma Z_{it} + \varepsilon_{it}$ based on different firm groups. Panel A to D group firms based on the downstream distance to the RE sector and the ownership structure and display the coefficients $\{\beta_s^g\}_{-4}^{8}$ along with the 95 c.i. respectively.

Figure A4 DYNAMIC EFFECTS OF THREE RED LINES POLICY ON NON-REAL-ESTATE FIRMS: SECOND-STAGE ESTIMATION



NOTE. The figure plots the coefficients β_s along with the 95 confidence intervals based on the second stage regression $I_{it} = \sum_{s=-5}^{5} \beta_s \times \exp\hat{o}_{it-1} * 1_{t+s} + \Gamma Z_{it} + \varepsilon_{it}$. The estimated exposure $\exp\hat{o}_{it-1}$ is constructed using first stage regression results on *Trade Credit Usage (TCL)*.

A Proof

Proof. The optimality conditions for real estate firms are given by

$$\alpha_1 p_1 y_1 = Rk_1(1+\lambda) \tag{A1}$$

$$\beta_1 p_1 y_1 = p_2 x_1[1+c(\gamma)+\lambda(1-\gamma)] \tag{A2}$$

$$c'(\gamma) = \lambda \tag{A3}$$

where λ is the Lagrangian multiplier on the financial constraint (2).

Using two equilibrium conditions, we get the following four equations (in logs),

$$\log y_1 = \alpha_1 \log k_1 + \beta_1 \log x_1 \tag{A4}$$

$$\log \phi = \log\left[\frac{\alpha_1}{1+c'(\gamma)} + \frac{\beta_1(1-\gamma)}{1+c(\gamma)+c'(\gamma)(1-\gamma)}\right] + \log p_1 + \log y_1 \tag{A5}$$

$$\log k_1 = \log\left(\frac{\alpha_1 p_1}{R}\right) + \log y_1 - \log[1+c'(\gamma)] \tag{A6}$$

$$\log x_1 = \log\left(\frac{\beta_1 p_1}{p_2}\right) + \log y_1 - \log[1+c(\gamma)+c'(\gamma)(1-\gamma)] \tag{A7}$$

The optimality conditions for non-real estate firms are given by

$$\alpha_2 p_2 y_2 = Rk_2(1+\mu) \tag{A8}$$

$$\beta_2 p_2 y_2 = wl_2(1+\mu) \tag{A9}$$

where μ is the Lagrangian multiplier on the financial constraint (5).

Using the production function and the constant return to scales assumption $\alpha_2 + \beta_2 = 1$,

$$1+\mu = p_2\left(\frac{\alpha_2}{R}\right)^{\alpha_2}\left(\frac{\beta_2}{w}\right)^{\beta_2} \tag{A10}$$

Therefore, the endogenous variables $\{y_2, k_2, l_2\}$ are given by

$$y_2 = (1-\gamma)p_2 x_1\left(\frac{\alpha_2}{R}\right)^{\alpha_2}\left(\frac{\beta_2}{w}\right)^{\beta_2} \tag{A11}$$

$$k_2 = \frac{\alpha_2}{R}(1-\gamma)p_2 x_1 \tag{A12}$$

$$l_2 = \frac{\beta_2}{w}(1-\gamma)p_2 x_1 \tag{A13}$$

With the intermediate goods market clearing condition, we have

$$\log\phi = \tilde{F}(\gamma) + \frac{\log p_1 + \beta_1(\log m + \alpha_2\log\frac{\alpha_2}{R} + \beta_2\log\frac{\beta_2}{w})}{1-\alpha_1-\beta_1} + \frac{\alpha_1\log\frac{\alpha_1}{R} + \beta_1\log\beta_1}{1-\alpha_1-\beta_1}$$

$$\log y_1 = \tilde{G}(\gamma) + \frac{(\alpha_1+\beta_1)\log p_1 + \beta_1(\log m + \alpha_2\log\frac{\alpha_2}{R} + \beta_2\log\frac{\beta_2}{w})}{1-\alpha_1-\beta_1} + \frac{\alpha_1\log\frac{\alpha_1}{R} + \beta_1\log\beta_1}{1-\alpha_1-\beta_1}$$

$$\log k_1 = \tilde{H}(\gamma) + \frac{\log p_1 + \beta_1(\log m + \alpha_2\log\frac{\alpha_2}{R} + \beta_2\log\frac{\beta_2}{w})}{1-\alpha_1-\beta_1} + \frac{(1-\beta_1)\log\frac{\alpha_1}{R} + \beta_1\log\beta_1}{1-\alpha_1-\beta_1}$$

$$\log x_1 = \tilde{Z}(\gamma) + \frac{\log p_1 + (1-\alpha_1)(\log m + \alpha_2\log\frac{\alpha_2}{R} + \beta_2\log\frac{\beta_2}{w})}{1-\alpha_1-\beta_1} + \frac{\alpha_1\log\frac{\alpha_1}{R} + (1-\alpha_1)\log\beta_1}{1-\alpha_1-\beta_1}$$

$$\log y_2 = \tilde{Z}(\gamma) + \frac{\log p_1 + \beta_1\log m + (1-\alpha_1)(\alpha_2\log\frac{\alpha_2}{R} + \beta_2\log\frac{\beta_2}{w})}{1-\alpha_1-\beta_1} + \frac{\alpha_1\log\frac{\alpha_1}{R} + (1-\alpha_1)\log\beta_1}{1-\alpha_1-\beta_1}$$

$$\log k_2 = \tilde{Z}(\gamma) + \frac{\log p_1 + \beta_1\log m + (1-\alpha_1-\beta_1\beta_2)\log\frac{\alpha_2}{R} + \beta_1\beta_2\log\frac{\beta_2}{w}}{1-\alpha_1-\beta_1} + \frac{\alpha_1\log\frac{\alpha_1}{R} + (1-\alpha_1)\log\beta_1}{1-\alpha_1-\beta_1}$$

$$\log l_2 = \tilde{Z}(\gamma) + \frac{\log p_1 + \beta_1\log m + \beta_1\alpha_2\log\frac{\alpha_2}{R} + (1-\alpha_1-\beta_1\alpha_2)\log\frac{\beta_2}{w}}{1-\alpha_1-\beta_1} + \frac{\alpha_1\log\frac{\alpha_1}{R} + (1-\alpha_1)\log\beta_1}{1-\alpha_1-\beta_1}$$

where

$$\tilde{F}(\gamma) \equiv \log\left[\frac{\alpha_1}{1+c'(\gamma)} + \frac{\beta_1(1-\gamma)}{1+c(\gamma)+c'(\gamma)(1-\gamma)}\right] + \tilde{G}(\gamma)$$

$$\tilde{G}(\gamma) \equiv -\frac{\alpha_1\log[1+c'(\gamma)] + \beta_1\log[1+c(\gamma)+c'(\gamma)(1-\gamma)]}{1-\alpha_1-\beta_1} + \frac{\beta_1\log(1-\gamma)}{1-\alpha_1-\beta_1}$$

$$\tilde{H}(\gamma) \equiv -\frac{(1-\beta_1)\log[1+c'(\gamma)] + \beta_1\log[1+c(\gamma)+c'(\gamma)(1-\gamma)]}{1-\alpha_1-\beta_1} + \frac{\beta_1\log(1-\gamma)}{1-\alpha_1-\beta_1}$$

$$\tilde{Z}(\gamma) \equiv -\frac{\alpha_1\log[1+c'(\gamma)] + (1-\alpha_1)\log[1+c(\gamma)+c'(\gamma)(1-\gamma)]}{1-\alpha_1-\beta_1} + \frac{(1-\alpha_1)\log(1-\gamma)}{1-\alpha_1-\beta_1}$$

We have

$$\frac{d\gamma}{d\phi} = \frac{1}{\phi\tilde{F}'(\gamma)} < 0$$

$$\frac{d\log y_1}{d\phi} = \frac{\tilde{G}'(\gamma)}{\phi\tilde{F}'(\gamma)} > 0$$

$$\frac{d\log k_1}{d\phi} = \frac{\tilde{H}'(\gamma)}{\phi\tilde{F}'(\gamma)} > 0$$

$$\frac{d\log x_1}{d\phi} = \frac{d\log y_2}{d\phi} = \frac{d\log k_2}{d\phi} = \frac{d\log l_2}{d\phi} = \frac{\tilde{Z}'(\gamma)}{\phi\tilde{F}'(\gamma)} > 0$$

due to the fact that $\tilde{F}'(\gamma), \tilde{G}'(\gamma), \tilde{H}'(\gamma), \tilde{Z}'(\gamma) < 0$.

Notice that $\frac{d\gamma}{dm} = -\frac{\beta_1}{(1-\alpha_1-\beta_1)m\tilde{F}'(\gamma)} > 0$. The sign of cross-derivate is given by

$$\frac{\partial}{\partial m}\left(\frac{\partial \log y_2}{\partial \phi}\right) = \frac{\partial}{\partial m}\left(\frac{\partial \log k_2}{\partial \phi}\right) = \frac{\tilde{Z}''(\gamma)\tilde{F}'(\gamma) - \tilde{Z}'(\gamma)\tilde{F}''(\gamma)}{\phi[\tilde{F}'(\gamma)]^2}\frac{d\gamma}{dm} \tag{A14}$$

With a linear structure of $c(\gamma)$, we have

$$\tilde{F}'(\gamma) = -\frac{\frac{\beta_1}{1+c(\gamma)+c'(\gamma)(1-\gamma)}}{\frac{\alpha_1}{1+c'(\gamma)} + \frac{\beta_1(1-\gamma)}{1+c(\gamma)+c'(\gamma)(1-\gamma)}} - \frac{\beta_1}{(1-\gamma)(1-\alpha_1-\beta_1)} \tag{A15}$$

$$\tilde{F}''(\gamma) = -\frac{\frac{\beta_1^2}{[1+c(\gamma)+c'(\gamma)(1-\gamma)]^2}}{\left[\frac{\alpha_1}{1+c'(\gamma)} + \frac{\beta_1(1-\gamma)}{1+c(\gamma)+c'(\gamma)(1-\gamma)}\right]^2} - \frac{\beta_1}{(1-\gamma)^2(1-\alpha_1-\beta_1)} \tag{A16}$$

$$\tilde{Z}'(\gamma) = -\frac{1-\alpha_1}{(1-\gamma)(1-\alpha_1-\beta_1)} \tag{A17}$$

$$\tilde{Z}''(\gamma) = -\frac{1-\alpha_1}{(1-\gamma)^2(1-\alpha_1-\beta_1)} \tag{A18}$$

Therefore, we have

$$\begin{aligned} &\tilde{Z}''(\gamma)\tilde{F}'(\gamma) - \tilde{Z}'(\gamma)\tilde{F}''(\gamma) \\ &= \frac{1-\alpha_1}{(1-\gamma)^2(1-\alpha_1-\beta_1)} \frac{\frac{\beta_1}{1+c(\gamma)+c'(\gamma)(1-\gamma)}}{\frac{\alpha_1}{1+c'(\gamma)} + \frac{\beta_1(1-\gamma)}{1+c(\gamma)+c'(\gamma)(1-\gamma)}} \left(1 - \frac{\frac{\beta_1(1-\gamma)}{1+c(\gamma)+c'(\gamma)(1-\gamma)}}{\frac{\alpha_1}{1+c'(\gamma)} + \frac{\beta_1(1-\gamma)}{1+c(\gamma)+c'(\gamma)(1-\gamma)}}\right) > 0 \end{aligned}$$

We thus have

$$\frac{\partial}{\partial m}\left(\frac{\partial \log y_2}{\partial \phi}\right) = \frac{\partial}{\partial m}\left(\frac{\partial \log k_2}{\partial \phi}\right) > 0 \tag{A19}$$

□